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Kane Experimental Forest

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Ensuring the future of the forests



Forest Service



U.S. Department of Agriculture



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Welcome to the Kane Experimental Forest

The 1,737 acres of forest land that comprise the Kane Experimental Forest (KEF), were originally part of the Allegheny National Forest. On March 23, 1932, the land was formally dedicated to research use for the Allegheny Forest Experiment Station (now the Northeastern Research Station). The KEF was established to promote the study of the unglaciated portion of the beech-birch-maple-hemlock forest type that made up such a large part of the Station's territory. Today, the Experimental Forest serves as the field laboratory for the research project "Understanding and Managing Forest Ecosystems of the Allegheny Plateau Region," which is headquartered at the Forestry Sciences Laboratory in Irvine, Pennsylvania.

The headquarters of the Kane Experimental Forest provide offices for Experimental Forest personnel, a conference building for meetings and training sessions, and temporary quarters for visiting scientists and students working on the forest. The office facilities are open year-round, while living accommodations are generally available May through October. The residential facilities provide rustic accommodations for college classes for a field trip, or longer term quarters for up to five residents.

SITE CLASSIFICATION

The Kane Experimental Forest is located within the Northern Unglaciated Allegheny Plateau Section of the Laurentian Mixed Forest Province in Bailey's (1994) ecological classification system for the United States. The Allegheny hardwood or cherry-maple forest is a subtype of the northern hardwood or beech-birch-maple forest that spans the northern portion of the eastern United States from New England to the Lake States.

The Kane Experimental Forest ranges in elevation from approximately 1,800 to 2,100 feet above sea level, primarily on flat to gently sloping land. The Mill Creek, Wolf Run, and Ackerman Run drainages cross the KEF as do the Mill Creek and Twin Lakes trails.

The climate of the Kane Experimental Forest is humid-temperate. Annual rainfall is about 45 inches, of which an average of 4 inches per month falls during the growing season. The average annual temperature is 43 degrees Fahrenheit.

The Kane Experimental Forest soils on the Plateau are derived from shales and sandstones. In general, they are extremely stony loams and sandy loams. They are strongly acidic. The major soils are the well-drained Hazelton series, the moderately well-drained to somewhat poorly-drained Cookport series, and the somewhat poorly-drained Cavode series.



View of the original office and garage. The bunkhouse as it is now called accomodates summer students and visiting college classes.

COMMUNITIES

Most stands on the Experimental Forest are typical Allegheny Plateau second- and third-growth forest. They resulted from a series of cuttings made in the original beech-birch-maple-hemlock forest. The first cutting, made in the mid- to late-1800s, removed the hemlock and the best hardwood trees to supply local tanneries and sawmills. Most of the remaining hardwoods were cut between 1890 and 1925, but a few stands were clearcut as late as 1937. These later cuttings were complete clearcuts to supply the local chemical wood plants with wood of all species and size classes. Today, the Kane Experimental Forest contains second-growth stands ranging from 50 to 100 years of age, a few third-growth stands from 10 to 40 years old, and one tract containing remnant old growth. Most stands are even-aged in character, although they may contain trees of several age classes because of the previous sequence of cuttings. The most common tree species are black cherry, sugar and red maple, and American beech; but many other species are present, including yellow and sweet birch, eastern hemlock, cucumbertree, yellow-poplar, white ash, and others. Several species of ferns, grasses, goldenrod, and aster occur in abundance as ground covers. Common spring ephemerals include trout lily, dwarf ginseng, and spring beauties. The wildlife communities found on the forest are typical of those found in managed and unmanaged forests of the Allegheny Plateau region. At least 26 species of amphibians and reptiles, 95 bird species, and 45 mammalian species have been known to occur in the area throughout the year.

HISTORY AND PAST RESEARCH ON THE KANE EXPERIMENTAL FOREST

The main emphasis of research at the time the Kane Experimental Forest was established, was to develop silvicultural methods for improving quality and yield of forests on the Allegheny Plateau. Various timber stand improvement projects set up in the 1930s, looked at such things as stump treatments of black cherry to reduce sprouting after clearcutting, pruning of hardwoods to facilitate growth, and weeding of hardwood stands to improve their value and composition. Four weather stations were established on the Experimental Forest in 1932, each in a different location. Air temperature, precipitation and other climatic data were recorded and compared to vegetative growth at the same site to determine the influence of environmental factors on tree development. Much of the labor for the field work of these studies came from Civilian Conservation Corps (CCC) camps located in the vicinity. The KEF was

closed during World War II, and after the war, a small silviculture research program was maintained both here at Kane and at the Pocono Experimental Forest, Gouldsboro, Pennsylvania. A long period of reduced activity followed that lasted until the late 1950s. It was only due to the perseverance of a few dedicated scientists that many studies were maintained and remeasured during this lull. In 1959, the Kane Experimental Forest was revitalized by combining the staffs of the Kane and the Pocono Experimental Forests and the establishment of the Forestry Sciences Laboratory in Irvine, PA. The research staff was expanded in 1970 and this combined with the reopening of 1930s studies provided for the rapid accumulation of scientific knowledge on the ecology and management of Allegheny hardwoods. A sampling of this research is listed below with more detailed descriptions of other active studies found in the Self-Guided Tour section:

1) Regeneration studies: Studies of the environmental factors affecting the natural regeneration of Allegheny hardwoods began in 1971. The effects of light, heat, and moisture were investigated to evaluate the contribution of each to the establishment and growth of tree seedlings, shrubs, ferns, and grasses. Techniques included cutting, roto-tilling, irrigation, bending overstory trees, trenching, soil heating, fertilization, and shading. These studies led to detailed guidelines for the use of shelter-wood cutting to develop advance regeneration in Allegheny hardwood forests. Other regeneration studies showed that hay-scented and New York fern interfered with the development of seedlings of desirable hardwood species and led to the development of herbicide/shelterwood prescriptions.

2) Regeneration cutting methods: A study of cutting methods and their effects on the survival and growth of advance regeneration and new seedlings was established in 1973. The methods included a two-cut shelterwood (6 acres), clearcutting alternate strips (66 feet wide), and block clearcutting (26 acres). The regeneration response was evaluated on the number of stems per acre by species, the percent stocking, and the survival and growth of both advance regeneration and new seedlings.

3) Thinning plots: In 1974, an experiment designed to test the effects of both the density and structure left after thinning in even-aged stands was installed on the KEF. Three blocks are located here, containing more than thirty 2-acre treatment plots. From this study, we have learned a great deal about how thinning response varies with density, structure and species composition. The responses we have studied include overstory



Phil E. Ackerman, first superintendent of the Kane Experimental Forest, and family in front of office building, April 1937.



Civilian Conservation Corps camps located in the vicinity of the KEF provided field crews for many early studies.



Mowing, a type of stand improvement cutting, was utilized in the 1930s to improve value and composition of hardwood stands.



Early attempts to control black cherry stump sprouting included girdling, peeling, and manual removal of new sprouts.

tree growth as well as regeneration and other understory responses.

4) Atmospheric monitoring: In 1978, one of the first National Atmospheric Deposition Program monitoring stations was set up at the Kane Experimental Forest. This site (PA29), located near the KEF headquarters, has been monitoring atmospheric data on a 24-hour-basis up to the present time.

PRESENT RESEARCH

Besides continuing with already established studies, current research at the Kane Experimental Forest focuses on understanding the

complex interrelationships of all the components affecting Allegheny hardwood forests today. To this end, research on the Kane Experimental Forest focuses on three topics:

1) Regeneration and forest renewal: Second-growth forests across the region have high economic value and harvesting rates. However, managers are encountering major problems in establishing a diverse third-growth forest. A key factor is the high density of white-tailed deer in the region, not only now, but for at least 50 years. Deer have altered the species composition of forest understories, changed habitat conditions for forest wildlife, and interfered with the establishment and development of tree regeneration. Studies on the Kane Experimental Forest have led to the development of techniques that allow for successful regeneration of forest stands in spite of high deer densities. These include: control of interfering vegetation, shelterwood seed cutting, fertilization of developing young stands, and fencing to exclude deer.

2) Stand dynamics and silviculture: Forest management goals are a lot more complex than they were in the past. Today, forests are managed for wildlife, recreation, water resources and aesthetic beauty in addition to timber. Studies at Kane are designed to integrate all of these resources and help managers grow forests with the most social and economic benefits. The facilities at Kane serve as the summer base for wildlife research done in conjunction with current studies. Data are collected to assess the responses of songbird, small mammal, and amphibian communities to forest management in studies across the Allegheny Plateau.

3) Sugar maple decline: Since the 1980s, forest health problems have greatly impacted forests across the Plateau. Moderate to severe droughts have occurred in 1988, 1991, and 1995, stressing trees across the Allegheny National Forest. Since 1991, native defoliators, including elm spanworm, cherry scallop shell moth, and forest tent caterpillar, have produced moderate to serious defoliation on 385,000 acres of the Allegheny National Forest, including



Ice storms hit the Kane Experimental Forest Area in 1936 and 1950. These storms provided the means to study how such damage affected tree growth and quality.

the Kane Experimental Forest. Two exotic defoliators, gypsy moth and pear thrips, and one exotic disease complex, beech bark disease, have affected 317,000 acres of the Allegheny National Forest since 1985. Finally, sugar maple is suffering a decline across the unglaciated sections of the Plateau. In 1992, a forest health monitoring system was implemented on the KEF to document insect, disease, and environmental conditions on the forest. A visit to each active study site is conducted annually and observations are taken on stand and tree health. Weather damage, crown dieback, defoliations, seedling mortality, and browsing damage are some of the conditions that are recorded. This information is analyzed in conjunction with the study data so that forest health impacts can be separated from treatment impacts.

SELF-GUIDED TOUR

The following are descriptions of seven current research studies. These sites are set up to facilitate a self-guided 1-day tour. The locations of each are highlighted on the map found in the center of the brochure. Several sites have trails running through them and include signs that describe the research conducted at

that location. Although the marked stops cover only a small portion of the research currently taking place, they are fairly representative of the important studies being conducted throughout the Kane Experimental Forest.



Sugar maple is suffering a decline across the unglaciated sections of the Allegheny Plateau. Scientists believe that a number of factors including drought, disease, and mineral deficiencies are responsible.

1) Clearcutting of second growth: This area shows how today's forest can be influenced by seemingly unimportant events of years ago. The original stand of trees here was partially harvested one or more times during the latter half of the 19th century, then first clearcut in about 1895.

In 1936, the new stand was heavily damaged by an ice storm. Foresters decided to regenerate the stand again, rather than allow the ice-damaged trees to continue to grow. Logging was done by teams consisting of two loggers and a horse, each assigned to a strip of forest about 60-feet wide. The loggers would cut the trees so that they fell with their tops toward the edges of the strip. They would then cut off the main stems and have the horse pull them out to the road through the center of the strip. In the center of the strip, all trees, down to those only an inch or so in diameter, were cut. But near the edges, loggers did not want to wade through the brush from fallen tree tops to get such small trees. Therefore, in these brush piles, small trees of the slower growing species like sugar maple and American beech were left, while in the center, only stumps and new seedlings were left.

Today, in the center of the strips, the only large trees are black cherry, the fastest growing species in the new stand. The sugar maple and beech trees left in the strip-edge brush piles are the only trees of those species that are as large as the largest black cherry trees. Foresters often describe stands by the number of complete harvests that have occurred since the original forest. Thus, this stand, with two cuttings since the original forest, is called third growth.

2) Older growth tract: This area is approximately 74 acres and is dominated by American beech and sugar maple. Two trails, the Twin Lake and Mill Creek, run through the area. The trails can be followed as they wind through the forest. The stand boundaries are marked with white paint, so you will know when you exit the stand. As you walk along the trails, notice the high percent of large sugar maple and younger black cherry trees. Historically, old-growth tracts on the Allegheny Plateau did not contain such a high percent of sugar maple or black cherry, but were mostly eastern hemlock and American beech. It is believed that this area of the Kane Experimental Forest has a unique disturbance history including windstorms, fire, and cutting. Such disturbances, especially over the past 100 years, resulted in the unique characteristics we see today.

This area, although never clearcut, has had three partial cuts, the first one early in the 1900s, the second between 1941-1951, and the third in 1951-1956. In each cut, individual trees were

selected and harvested. At the turn-of-the-century cut, hemlock was selectively removed from throughout the area. In many of the places created by this hemlock removal, we find patches of 100-year-old black cherry trees.

As you walk through the stand, notice the beech trees. The white "dust" you observe on them is the first stage in the beech bark disease complex. A tiny insect, the beech scale, bores into the bark and secretes the wool-like wax substance. The second stage occurs when the *Nectria* fungus, using the holes created by the beech scale, invades the tree. The fungus is characterized by its reddish-orange fruiting bodies. The fungus kills patches of the tree's cambium. As these patches coalesce overtime, the fungus girdles the tree.

Also, notice that many of the sugar maple trees are dying. This tends to happen from the top down. You can see how many of the trees have no crowns and some only have a few live branches very low on the tree. Scientists believe that several factors are responsible for this decline, including: drought, insect defoliations, disease, and mineral deficiencies (magnesium and calcium).

3) Thinning plots: Nature handles crowding among trees in a forest through the death of small trees and the slow growth of large ones. In a crowded forest, there is little food or cover for wildlife near the forest floor, as there is not enough light for tree seedlings or small plant growth. Foresters may want to interrupt nature's handling of crowding for a variety of reasons. These include growing wood products more efficiently, changing the habitat conditions for wildlife, or changing the scenic conditions for forest recreation.

On this stop, you will walk through an experiment to determine the level of crowding that is most efficient for growing high value wood products. Crowding is measured as the percent relative density for a stand. This percent is an estimate of the crowding in the stand compared to a 100-percent standard representative of an undisturbed stand of the same species composition and average tree size. Experimental thinnings were conducted on treatment plots of this experiment in the early to mid-1970s and again in the early 1990s. On the south side of the road, the trail goes through four plots at different crowding levels. Signs are posted at each plot and you can refer to the map in the center of this guide to see their location along the trail.

The first, or 100-percent plot has never been thinned. Notice the number of dead trees in this

plot and look up to see the small size of the crowns of surviving trees.

The second plot was cut to 80 percent relative density in 1974 and 1991. This light thinning treatment opens the canopy for only a short period of time, as the growth of residual trees fills in the openings quite quickly. Notice that the understory plants in this treatment, mostly striped maple, are considerably higher and denser than the understory in the control plot. Even though these light thinnings increased light levels reaching these understory plants for only a short period, they responded with increased growth. Large trees did not develop new low branches under this treatment, and increases in tree growth rate are minor.

The third plot, which was cut to 60-percent relative density in 1974 and 1991, is intermediate between the 40-percent and 80-percent thinning treatments in crown size, rate of tree growth, development of forest floor plants and in development of low branches on large trees. This 60-percent treatment is the one that we recommend to forest managers who want to grow high

value wood products in stands with high proportions of red maple, sugar maple, or oak.

In 1974 and 1991, the last tour plot on this side of the road was cut until 40-percent relative density remained. Especially in the first cut, trees of all sizes were removed, but the majority of trees cut were from the smaller size classes. Large trees were cut only if they were in poor health or of poor quality, or to create room for the crowns of the very best trees to expand. After the first cut, the residual trees even in this heavy thinning eventually closed the canopy completely again. This has not, however, happened since the second thinning. In that thinning, we were forced to cut more large trees to achieve the residual density that the experiment required. Notice how large the crowns of the tallest trees have become as a result of the thinning. Notice, too, the low branches on the trunks of these trees as a result of increased growing space. Finally, notice that the understory here is very dense and complex, consisting of American beech, black birch and a few scattered trees of other species. The 40-percent treatment had created a two-aged stand with the seedlings that started after the first thinning occupying a significant portion of the stand's growing space.

Continue your tour on the north side of the road. Here, you go through three more plots that are part of the same experiment. In these plots, which were cut in 1975 and again in 1991, the level of crowding was kept the same, but different groups of trees were removed from each plot; that is, the structure of the forest was altered.

In the thin-from-below plot, loggers began with the smallest tree in the stand and kept selecting the next smallest until 60-percent relative density was reached. Most of the trees that were removed were too small for any use and the large trees that were left, have not grown faster than they would have if the cutting was never done.

In the thin-from-the-middle plot, loggers began with the smallest trees large enough to sell to paper pulp producers and kept selecting the next largest until 60-percent relative density was reached. Much of the growth benefit of this treatment has gone to trees that will not grow large enough to sell for many decades. And in the largest trees, many low branches remain, reducing future lumber quality.

In the thin-from-above treatment, also called "diameter limit cut," loggers began with the largest trees in this stand and kept selecting the next smallest until 60-percent relative density



Tree heights are one of the many measurements periodically taken on study sites.



Extensive studies have shown that thinning a stand to 60- to 75-percent relative density is ideal for growing high value wood products.

was reached. The smallest trees that were left were not prepared for full sunlight and many of the trees died in the first 5 years after the first cutting treatment in 1975. This treatment also tends to result in a decrease in final timber values.

The thinning plots that you have visited here are part of a larger experiment, consisting of more than 60 plots in northwestern Pennsylvania and southwestern New York. Forest stands of many ages and species compositions are represented. The diversity of plots within this experiment has allowed us to refine our thinning guidelines recently. We suggest that target residual density should vary by species composition. In stands dominated by shade-tolerant species, lower residual densities are better, while in stands dominated by less shade-tolerant species like black cherry, white ash, and yellow-poplar, higher residual densities are preferred. Our research shows that for the production of high quality wood products, thinning to 60- to 75-percent relative density by removing mostly smaller trees and enough larger trees to provide room for crown expansion of the residual trees is best.

4) Herbicide/shelterwood treatment and biodiversity: The goal of any regeneration cutting

is to ensure the establishment of the next stand. This can only occur if there is enough regeneration present to allow this to happen and interfering plants are not hindering growth and development of trees. Herbicide/shelterwood is the cutting method employed when not enough advance seedlings are present and interfering plants are a problem. Herbicide use is required to remove understories of ferns, grasses and sedges, striped maple, and beech that interfere with regeneration. Herbicides are applied first, followed by the shelterwood cut, which reduces the overstory to 60-percent relative density. This allows additional sunlight, moisture, and nutrients to be available for the establishment of new seedlings. In 1994, the Allegheny National Forest and the Northeastern Research Station began a 10-year cooperative study to determine the short- and long-term changes in species diversity of herbaceous and woody vegetation, small mammals, songbirds, and amphibians resulting from a single commercial application of a herbicide mix, [glyphosate and sulfometuron methyl, or Roundup (TM) plus Oust (TM)] combined with a shelterwood cut. This area represents one of 10 approximately 20-acre stands that are being studied. Each stand is split in half with one-half receiving the herbicide treatment and the other half serving as the control. These areas were treated in the fall of 1994.

To achieve the goals of this study, we gather data on all five of the communities of interest every other summer. We measure the ground cover of non-woody plants on 30 sample plots twice each season; once in spring, when spring wildflowers are in bloom, and once in midsummer, when ferns are fully expressed. We count tree seedlings on a different set of plots during each summer, identifying them by species and several height classes. Twice each summer, we place 100 live traps on a grid throughout the stand, visit the traps daily for 4 days and identify the small mammals caught.

To assist in the capture of shrew and amphibian species, we place pitfall traps at planned locations throughout the stand. These traps are below the level of the ground surface and both small mammal and amphibian species fall in and can be censused when we visit the live trap grids. In addition, sets of 12 hemlock boards placed in a 4 x 3 pattern along the trapping grids are "run" periodically throughout the summer by lifting them and recording information on any captured salamanders. Songbird surveys are done three times each season. A skilled observer visits eight marked spots throughout the stand in the early morning hours and for 5 minutes records all birds seen or heard within a radius of 100 feet.

The boundary of this site is painted in white and the midline separating the two sides is painted with white strips. A successful herbicide application allows for regeneration growth before interfering species can come back and take over the stand again. As you walk through the site, observe how the structure and composition of the vegetation changes between the treated and untreated sides. Please feel free to observe, but not disturb, data collection sites.

5) Crop tree plots: This is an example of thinning with careful consideration of crop trees. We have chosen as crop trees those with the characteristics that make them valuable for timber production. These are mostly black cherry trees with large diameters, straight trunks, and maximum length of stem to their first branches. We also tried to choose trees that were evenly spaced throughout the area. This same treatment could be done using wildlife or aesthetic values as the deciding criteria instead of timber production value.



Small mammal trapping is one technique used to assess the response of wildlife to different silvicultural treatments.



Board complexes are used to survey salamander populations.

At each plot in this experiment, we have marked the crop trees with a ring of white paint. This includes the plot where we have done no cutting, so that we can compare the growth of crop trees in an uncut stand with the various treatments. The cutting in these stands was done during the winter of 1989. A trail winds its way through the five different treatment stands.

In the first plot, we removed all trees whose crowns were touching those of the 60 crop trees that we designated per acre, unless the touching crown belonged to another crop tree. Notice the spacing between the trees. This seems to be ideal for growing big trees quickly.

The second plot is an uncut plot. Notice how much more crowded it feels and how much smaller the crop trees are.

In the third plot, we used the results from our thinning study and cut the stand to 60-percent relative density. This traditional treatment in which we remove trees predominately of the smallest sizes and some large trees to create room for the crowns of residual trees to expand, does not require formal identification of crop trees. But we did designate 60 crop trees per acre after we

thinned here, so that we could compare their growth in a plot treated in the traditional way with the growth of crop trees in treatments that specifically released them from competition.

In the fourth plot, the treatment was to remove all trees whose crowns touched those of the 40 crop trees per acre that we chose. Here, you can see that much of the growth since the cutting has been in forest floor plants—ferns, raspberry, and some tree seedlings, instead of in the selected crop trees.

In the fifth plot you enter, the treatment was to remove all trees that were merchantable as forest products, except the 60 crop trees per acre. Here, too, trees are not using all the growing space.

In addition to these plots, there are two other groups of crop tree plots elsewhere on the Allegheny National Forest. One is in an oak stand and the other is in a young third growth forest.

Results from this study indicate that good thinning techniques, whether or not we focus on crop trees or use more traditional area-wide techniques, produces the same positive result. Efficiency of high value wood production was increased and understory development was kept



Selecting crop trees allows forest managers to monitor trees with the characteristics they deem the most valuable.

low except where too many trees were removed, as in the fourth and fifth plots.

6) Residual tree cutting: Remember stop 1, from which we learned that leaving small, slow-growing trees like sugar maple and beech at the time of a clearcut would ensure their presence as large trees of seed-bearing size in the new forest that developed? This site is an experiment to test that method in today's forest.

In 1982, this stand was clearcut. Before the cutting, foresters selected 31 sugar maple and beech trees per acre with good crowns and straight stems with no low branches. These residuals were marked with a ring of white paint and protected during the final harvest.

In 1985, this stand was fertilized with nitrogen and phosphorous dropped from a helicopter. This treatment allows the young seedlings to rapidly grow out of the reach of browsing white-tailed deer. Notice that the young cherry stems are catching up to the residual sugar maple. Our research suggests that the cherry will catch up with the maple in height sometime around 2020.

The residual trees suffered from the stresses of drought and late spring frosts in the first years after cutting and by 1987, about 10 percent of them had died. Then, in the early 1990s, the trees underwent several years of elm spanworm defoliation and more drought. Nonetheless, many are growing and surviving and a close look at the younger stems will show that the residual trees are the only maple, beech, and hemlock in the new stand.

We recommend this treatment, even though a percentage of the residual trees have died, because it is the surest way of maintaining diversity in a stand. Diverse stands are less vulnerable to insect attack, have better nutrient cycling regimes,

produce higher quality timber, are better for wildlife, and ensure seed source for diverse stands in the future.

7) Management strategies plots: You will need to walk down the gated old logging road about a half mile to a sign that starts this tour. The hike may take about an hour, depending on how frequently you stop. At the center of the trail's path through each treatment plot, there is a sign that will help you recognize the stops on this tour. Each sign (after the introductory one where the trail turns off the logging road) has the name of the treatment on it.

The purpose of this study was to explore the results associated with several different management strategies in Allegheny Plateau forests. Each strategy involves a pattern of forest development and an associated pattern of management actions, and each has benefits and drawbacks. By applying each of these strategies several times within a small (about 100 acres) area of similar forest, we can learn about these benefits and drawbacks in much more detail. We chose this stand because it includes trees of at least two distinct age classes. The first age class resulted from the partial harvests conducted in this stand during the 1860-1880 era, when partial cuts were common. Then around 1900, a very heavy partial cut was completed in this stand. So, prior to the start of our experiment in 1980, this stand contained some trees that were about 80 years old and some that were at least 100 to 120 years old. As you walk down the trail to the start of the experiment, you can see patches of nearly pure black cherry that probably developed where the turn-of-the-century cutting was particularly complete, and patches of hemlock that were probably left when the partial cutting was made in 1900. There are four replicates of the treatments here and one other replicate located in an oak stand elsewhere on the

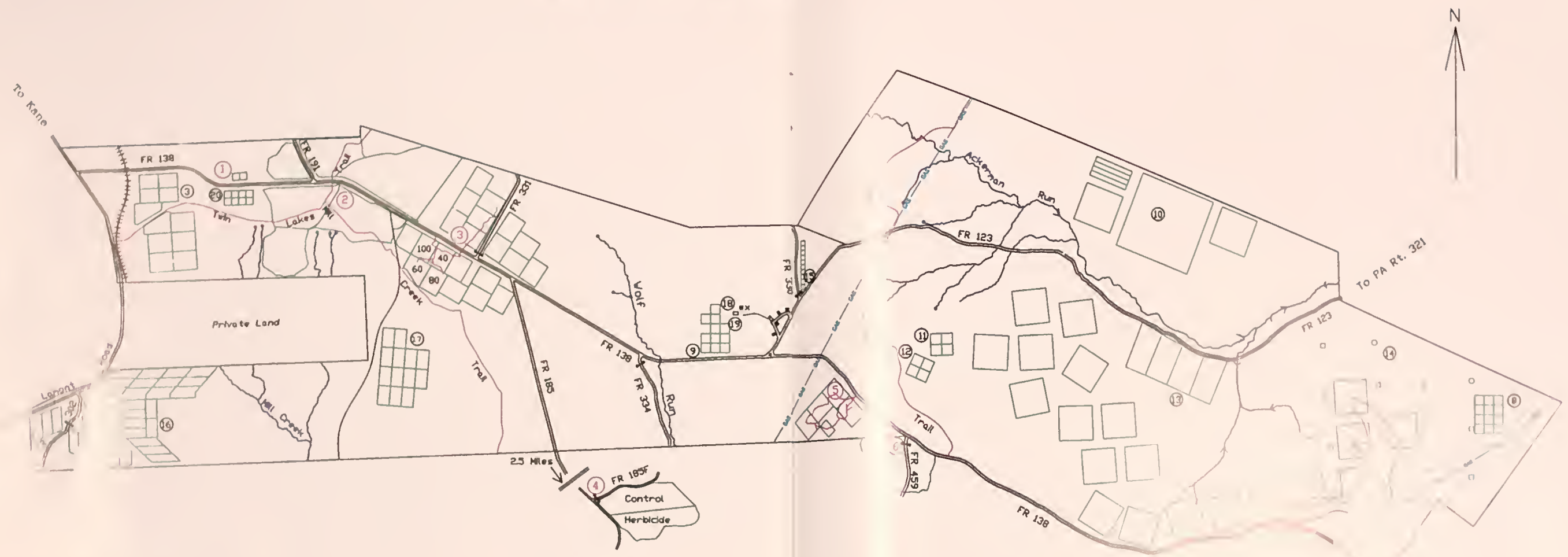
Allegheny National Forest. The plots on the trail were last treated in 1980. During the 1990s, this stand has been heavily influenced by sugar maple decline. Mortality of sugar maple has been so high that none of the plots are ready for second treatments as scheduled in the year 2000. Studies conducted elsewhere by our unit have indicated that sugar maple decline occurs when trees with low levels of some key nutrients are exposed to stresses like defoliations and droughts several times within the same decade.

The first plot you visit is being managed with classic even-age silvicultural techniques. These techniques are designed for managing a group



Since the early 1990s, a series of native and exotic defoliators, like the elm spanworm, have impacted thousands of acres of KEF and surrounding National Forest land.

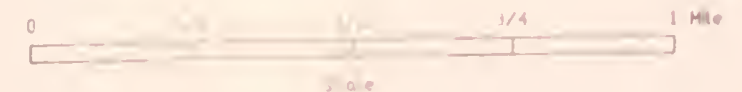
KANE EXPERIMENTAL FOREST



Cutting of 35-40 year-old second growth, 1937
 Second growth tract, 1932
 Training plots, 1974
 Herbicide/Shelterwood treatment and biodiversity, 1994
 Strip tree v. area-wide thinning, 1989
 Individual tree cutting, 1982
 Management strategies study, 1980

OTHER ACTIVE STUDIES:

- 8 Weeding block 1 - effect of early weeding on future composition and value of hardwood stands, 1932
- 9 Weeding block 2 - effect of early weeding on future composition and value of hardwood stands, 1932
- 10 Regeneration Study - effect of different cutting methods on survival and growth of regeneration, 1973
- 11 Bear tree plot 1 - improvement thinning in a 40-year-old second-growth stand, 1973
- 12 Bear tree plot 2 - improvement thinning in a 40-year-old second-growth stand, 1973
- 13 Cutting practice levels - four different methods of harvesting second-growth Allegheny hardwood-hemlock stands, 1952-53
- 14 Yield 'R' plots - sample rate of growth following glaze damage salvage cutting, 1937
- 15 'Orzetti' plots - semi-permanent tally strip to follow residual stand after salvage cutting in 40-year-old cherry-maple stand, 1936
- 16 Demonstration area - one-acre plots used to teach regeneration practices, 1997
- 17 Training area 'C' - one-acre plots used to teach silvicultural practices, 1995
- 18 National Atmospheric Deposition Program - PA-29, 1978
- 19 EPA monitoring station - 1990
- 20 Shelterwood removal and mowing of reproduction - mowing of advance regeneration after final shelterwood cutting, 1938





A clearcut area, eight growing seasons after cutting, 1959.



The same clearcut area 40 years later, 1996.

of trees of a very narrow range of ages (a stand in which all trees regenerated at essentially the same time, either through a natural disturbance or a timber harvest). This stand was thinned in 1980 to a 60-percent relative density. The trees that were removed were generally from the smaller merchantable size classes, but some large trees were removed to allow residual tree crowns to expand. The biggest and best trees will grow until perhaps 2020, and then the stand will be clearcut. The benefits of this strategy include rapid growth of valuable, large trees like black cherry, that thrive in high sunlight conditions created by this management strategy. The drawbacks of this technique are the unpleasant appearance of even-age stands in the first few years after clearcuts or shelterwood removal cuts. In this older stand, crown closure did not occur after thinning. Sugar maple decline also reduced relative density. As a result, a new age class dominated by black birch developed in the understory.

The second plot you visit is being managed with techniques called economic selection. The intent is to develop a stand in which trees of many different age classes, each about 20 years apart, coexist next to each other. In this treatment and the next two, we divided the growing space among the trees of different size classes using our growth factors to determine how many trees of each size class we had room for, and removed the excess. In this particular treatment, we tried to do this without removing any trees too small to be used for sawtimber (sawmills require trees with a diameter chest height of about 12 inches for sawtimber products). We hope that this management strategy will be useful on small forested properties, where marketing small trees might be difficult, but where landowners want to manage for a diversity of forest resource benefits. Cutting stimulates the growth of the plants on the forest floor providing food for wildlife and carefully managed cutting ensures that the best trees are not removed all at once. The benefits of this management strategy include the easy marketability of its products and the avoidance of clearcut appearance. But for it to succeed, species that can germinate and grow in the partial shade of a forest canopy that includes trees of all sizes and heights must grow past the reach of the deer. So far, the new age class is sparse; instead there are many ferns, not tree species. Species that are very valuable for timber production and wildlife food production, like the oaks and cherry, do not grow well in these partially shaded conditions, even though cherry is less preferred by deer. The heavy browsing of tree seedlings by deer is a pervasive feature of these forests and a substantial threat to their regeneration.

The third plot you visit is being managed with techniques called group selection. Trees that were merchantable for both timber and paper pulp

production were removed from the stand. As in the previous plot, trees were designated for removal when there were too many trees of a given size on the plot. In addition, we purposely created openings up to a half-acre in size throughout the stand. In this opening, we are having some success where the tops of trees cut in the 1980 harvest have denied deer access to valuable tree seedlings. This management strategy may offer some of the best benefits, if the deer do not eat all the valuable sun-loving species in the openings and all the more shade-loving species that grow between the openings. So far, we don't observe this happening.

The fourth plot you visit is being managed with techniques called single-tree selection. This is another technique in which trees of all ages will coexist in one stand. In this variant of the technique, only openings resulting from single-tree removals have been created. Trees merchantable for both paper pulp and timber products were removed in this treatment. The residual density in this stand has been reduced to 60 percent, although the sizes of the trees removed is quite different from those removed in even-aged thinnings. It is hard to believe that there was a timber sale here in 1980, which is perhaps the greatest benefit of this strategy. But despite having all the right species for seed source in the original stand (sugar maple, beech, hemlock and other shade-loving species that should prosper under this strategy) there is little regeneration. The regeneration that is occurring is of American beech, often growing as root suckers off of existing trees. Not only does beech have a very low value for wood products, it is the victim of beech bark disease that is rapidly spreading into this area. Once again, deer are a primary reason for the lack of regeneration. The beech sucker plants seem more resistant to deer browsing probably because they have access to the energy stored in the roots of mature trees.

The final plot on this stop demonstrates a two-age management strategy. This strategy is a cross between the strategies that maintain several different age groups of trees on the site at any time and even-age strategies that replace one single-age crop of trees with another. We will remove more than two-thirds of the mature trees on this plot at the next treatment, creating conditions of abundant light almost like a clearcut, but without removing the overstory completely. We would like to keep the trees from the original stand for perhaps 40 years after that, until the new age class of trees has the appearance of a young forest stand. Then we will harvest the oldest trees and thin the new age class, creating conditions that will allow seedlings of sun-loving species to grow again. This strategy may be the only

way that we will be able to maintain the presence of a high proportion of seedlings of sun-loving, high-value species while still avoiding the appearance of fresh clearcuts. In this stand, however, beech present as small root suckers at the time of the 1980 thinning have been the main beneficiaries of that treatment.

TECHNOLOGY TRANSFER

Scientists at the Irvine laboratory emphasize the need to bring research results to the public. Our technology transfer programs are created to help resource professionals, landowners, and the general public appreciate the importance of sustainable forest communities through the application of research results. Annual programs on the Kane Experimental Forest include:

1) Training for future foresters: Scientists at the laboratory host numerous college forestry and biology courses throughout the year at the Kane Experimental Forest. Abundant study and demonstration sites across the Experimental Forest provide excellent opportunities to teach students the basics of forest management in Allegheny hardwood stands.

2) Environmental education and tours: Various programs at the Kane Experimental Forest give local school groups an opportunity to learn everything from tree identification and forest health to wildlife habitat requirements. Information on careers in forestry, wildlife biology, and research are also shared. In addition, guided tours and slide shows are offered, by prior arrangement, for any interested group.

3) SILVAH Training sessions: Since its inception in 1932, studies on the Kane Experimental Forest have provided for the rapid accumulation of scientific knowledge on the ecology and management of hardwoods on the Allegheny Plateau region. Even early on, special efforts were made to organize that knowledge into a coordinated set of management guidelines. Initial guidelines included procedures to obtain satisfactory regeneration after harvest cutting and to control stand density and structure during thinning. These guidelines have since been expanded into a complete system of stand evaluation and silvicultural prescriptions that cover the full range of forest conditions and management alternatives in the region. Research results developed to date by the research project at Irvine have been incorporated into a systematic approach to silviculture called SILVAH (SILViculture of Allegheny Hardwoods), which aids foresters in managing Allegheny hardwood stands. Since 1976, this system for stand inventory, analysis, and prescription writing has been presented to resource professionals during week-long workshops held two to four times each year at the Kane Experimental Forest's conference building. Sessions are conducted by staff from the Irvine laboratory in cooperation with The Pennsylvania State University. This intensive course gives participants both the theoretical background information and active field experience in applying silvicultural guidelines to actual stands for both timber and non-timber values. The sessions are updated periodically as new research information becomes available. In addition, the SILVAH approach has been developed into a computerized decision model, also called SILVAH (version 5.0 is currently available).



Since 1976, SILVAH (SILViculture of Allegheny Hardwoods) training sessions have been held every year on the KEF. These courses provide participants with the opportunity to apply silvicultural guidelines to actual stands.



The Allegheny hardwood forest covers approximately 16 million acres of the Allegheny Plateau and Allegheny Mountain sections of Pennsylvania, New York, Maryland, West Virginia, and Ohio.

RESEARCH RESULTS APPLIED

The area occupied by Allegheny hardwoods is a heavily forested region. It is one of the major contiguous blocks of commercial forest land in the Northeast. Forests in the Allegheny Plateau region include the half-million-acre Allegheny National Forest, several districts from Pennsylvania's 2.1-million-acre State Forest System, several gamelands managed by the Pennsylvania Game Commission, municipal watersheds, hundreds of thousands of acres of industrially owned forest, and a similar acreage of non-industrial private forest. All of these forests are used for a variety of purposes, including timber production, wildlife habitat, outdoor recreation, and watershed management. They are important for conservation of biological diversity, for safeguarding the region's water supply, and for providing people with the experience of large blocks of contiguous working forest.

Research conducted on the Kane Experimental Forest and by USDA Forest Service researchers associated with the KEF has influenced the management of these forests for several decades. Inventory procedures and management guidelines developed by Irvine Laboratory researchers are standard practice on public lands throughout the

region, through use of the SILVAH computer program and participation of professionals in Silvicultural Training Sessions. When white-tailed deer browsing created a regeneration crisis in the region during the late 1960s and early 1970s, guidelines developed by Forest Service researchers enabled managers to improve their rate of successful regeneration after final timber harvests from 50 percent to more than 90 percent. These guidelines included inventory procedures for formal assessment of advance regeneration, the first such guidelines widely used in the eastern hardwood region. These procedures were later adapted for use by the USDA Forest Service, Forest Inventory and Analysis group for their 1989 inventory of Pennsylvania's forest resources. Guidelines developed by Forest Service researchers for herbicide treatment of plants that interfere with the establishment of diverse regeneration in Plateau forests are used annually by a variety of forest management organizations on several thousand acres. The on-going thinning studies on the Kane Experimental Forest have led to major advances in our understanding of forest growth and development in hardwood stands of mixed species composition, and guidelines based on this understanding are used throughout the eastern United States.

Guidelines developed by Forest Service researchers are mentioned as standards against which forest management practices were compared in assessments of both industrial and Pennsylvania State Bureau of Forestry management practices by Scientific Certification Systems, Inc.¹ during the 1990s. These ownerships, totaling more than 2 million acres, were among the first and largest forests in the eastern United States to receive certification as well managed by organizations approved¹ by the International Forest Stewardship Council.

¹ *The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.*

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- Society of American Foresters (SAF) Deer/Forest/Farm Committee
- SUNY - College of Environmental Science and Forestry
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- Wolf Run Forest Resource Partnership

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List of Publications from Research on the Kane Experimental Forest

- deCalesta, David S. 1994. **Effect of white-tailed deer on songbirds within managed forests in Pennsylvania.** Journal of Wildlife Management. 58(4): 711-718.
- Horsley, Stephen B. 1991. **Using Roundup and Oust to control interfering understories in Allegheny hardwood stands.** In: McCormick, Larry H., Gottschalk, Kurt W.; eds. Proceedings 8th Central Hardwood Forest Conference 1991 March 4-6. Gen. Tech. Rep. NE-148. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 281-290.
- Hough, Ashbel F. 1937. **A study of natural tree reproduction in the beech-birch-maple-hemlock type.** Journal of Forestry. 35: 376-378.
- Long, Robert P.; Horsley, Stephen B.; Lilja, Paul R. 1997. **Impact of forest liming on growth and crown vigor of sugar maple and associated hardwoods.** Canadian Journal of Forest Research. 27: 1560-1573.
- Marquis, David A. 1975. **The Allegheny hardwood forests of Pennsylvania.** Gen. Tech. Rep. NE-15. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 32 p.
- Marquis, David A. 1975. **Seed storage and germination under northern hardwood forests.** Canadian Journal of Forest Research. 5: 478-484.
- Marquis, David A. 1981. **Removal or retention of unmerchantable saplings in Allegheny hardwoods: Effect on regeneration after clearcutting.** Journal of Forestry. 79: 280-283.
- Marquis, David A.; Bjorkbom, John C. 1982. **Guidelines for evaluating regeneration before and after clearcutting Allegheny hardwoods.** Res. Note NE-307. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 4 p.
- Marquis, David A.; Ernst, Richard L. 1992. **User's guide to SILVAH.** Gen. Tech. Rep. NE-162. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 130 p.
- Marquis, David A.; Ernst, Richard L.; Stout, Susan L. 1992. **Prescribing silvicultural treatments in hardwood stands of the Alleghenies (revised).** Gen. Tech. Rep. NE-96. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 101 p.
- Nowak, Christopher A. 1996. **Wood volume increment in thinned, 50- to 55-year-old, mixed-species Allegheny hardwoods.** Canadian Journal of Forest Research. 26: 819-835.
- Ostrom, C. E.; Hough, Ashbel F. 1944. **Early weeding in northern hardwoods.** Journal of Forestry. 42: 138-140.
- Roach, Benjamin A. 1977. **A stocking guide for Allegheny hardwoods and its use in controlling intermediate cuttings.** Res. Pap. NE-373. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 30 p.
- Stout, Susan L., Redding, James A.; DeMarco, Lois A. 1995. **Technology transfer at the heart of a research/management partnership.** In: Silviculture: From the Cradle of Forestry to ecosystem management, Proceedings of the National Silviculture Workshop, Foley, Louise H., comp.; 1993 November 1-4; Hendersonville, NC. Gen. Tech. Rep. SE-88. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 188-193.
- Tilghman, Nancy G. 1989. **Impacts of white-tailed deer on forest regeneration in northwestern Pennsylvania.** Journal of Wildlife Management. 53 (3): 524-532.
- Yanai, Ruth D.; Twery, Mark J.; Stout, Susan L. 1998. **Woody understory response to changes in overstory density: thinning in Allegheny hardwoods.** Forest Ecology and Management, 102: 45-60.

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Glossary

Clearcutting -- A method of regenerating an even-aged stand in which a new age class develops in a fully-exposed microclimate after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings and/or advance reproduction.

Crop Tree -- Any tree that is selected to become a component of a future commercial harvest.

Crown -- The part of a tree or woody plant bearing live branches and foliage.

Even-Aged Stand -- A stand of trees containing a single age class in which the range of tree ages is usually less than 20 percent of rotation.

Herbaceous -- Fleshy, nonwoody plants. Does not include trees and shrubs.

Interference -- Any form of vegetation that prohibits desired species from growing.

Mowing -- A release treatment in stands at the saplings stage that eliminates or suppress undesirable vegetation regardless of crown position.

Regeneration -- Seedlings or saplings existing in a stand; or the act of establishing young trees naturally or artificially.

Silviculture -- The art and science of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Shelterwood Seed Cutting -- A method of regenerating an even-aged stand in which a new age class develops beneath the moderated micro-environment provided by the residual trees.

Stand -- A contiguous group of trees sufficiently uniform in age-class distribution, composition and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

Thinning -- A cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or to recover potential mortality.

Two-age -- A stand composed of two distinct age classes that are separated in age by more than 20 percent of rotation.

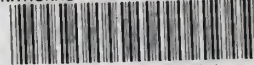
Weeding -- A release treatment in stands not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position.



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